

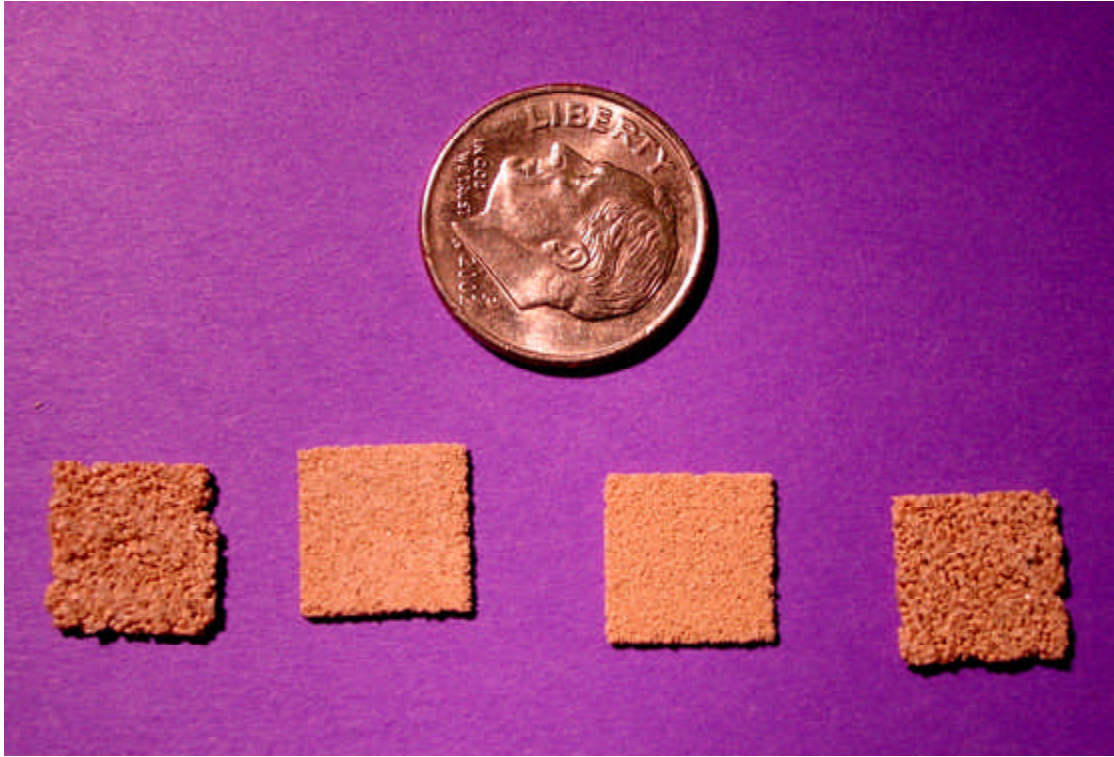
Stirling Microregenerators Fabricated and Tested

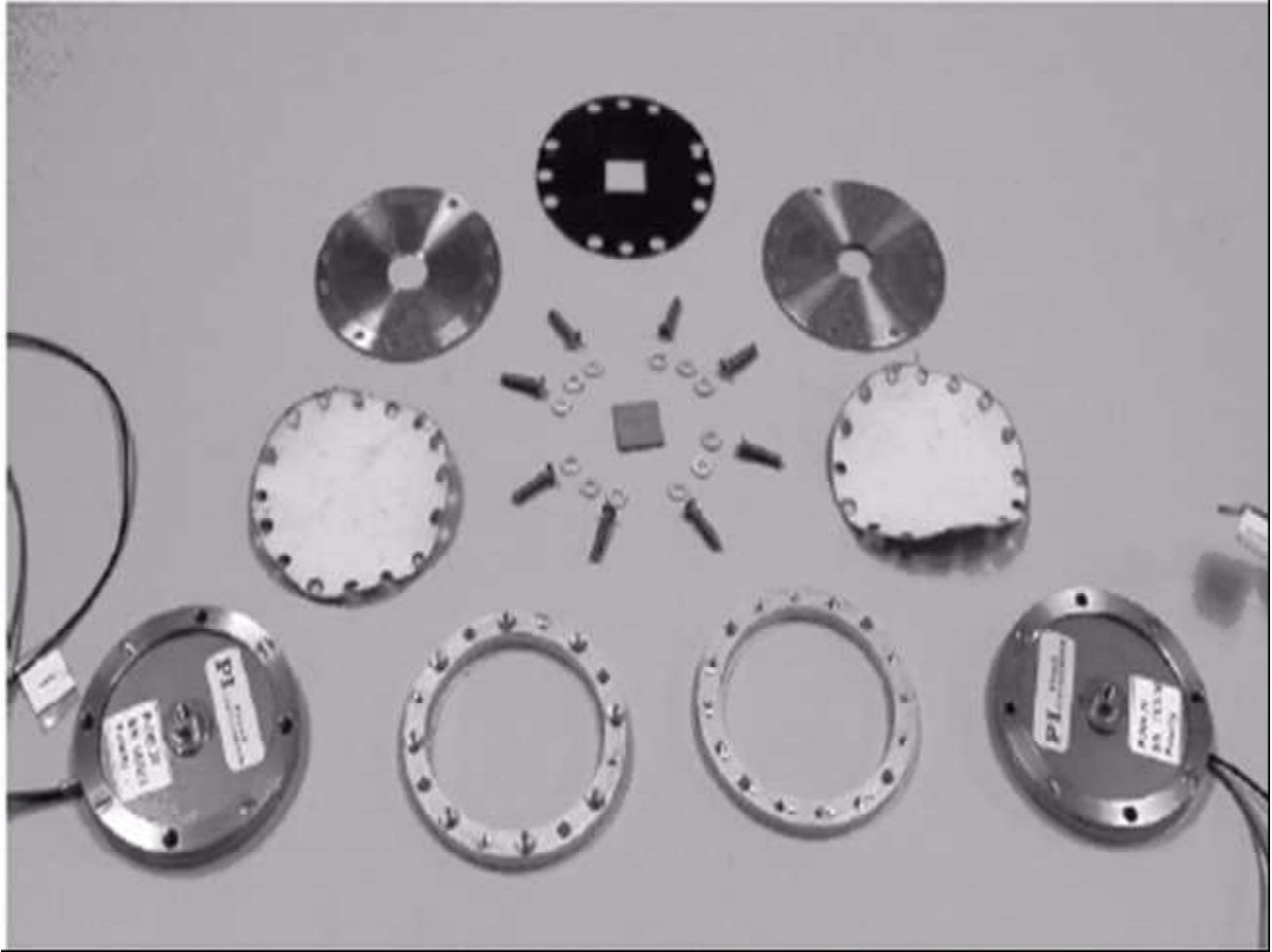
A mesoscale Stirling refrigerator patented by the NASA Glenn Research Center is currently under development. This refrigerator has a predicted efficiency of 30 percent of Carnot and potential uses in electronics, sensors, optical and radiofrequency systems, microarrays, and microsystems. The mesoscale Stirling refrigerator is most suited to volume-limited applications that require cooling below the ambient or sink temperature. Primary components of the planar device include two diaphragm actuators that replace the pistons found in traditional-scale Stirling machines and a microregenerator that stores and releases thermal energy to the working gas during the Stirling cycle.

Diaphragms are used to eliminate frictional losses and bypass leakage concerns associated with pistons, while permitting reversal of the hot and cold sides of the device during operation to allow precise temperature control. Three candidate microregenerators were fabricated under NASA grants for initial evaluation: two constructed of porous ceramic, which were fabricated by Johns Hopkins Applied Physics Laboratory, and one made of multiple layers of nickel and photoresist, which was fabricated by Polar Thermal Technologies.

The candidate regenerators are being tested by Johns Hopkins Applied Physics in a custom piezoelectric-actuated test apparatus designed to produce the Stirling refrigeration cycle. In parallel with the regenerator testing, Johns Hopkins is using deep reactive ion etching to fabricate electrostatically driven, comb-drive diaphragm actuators. These actuators will drive the Stirling cycle in the prototype device.

The top photograph shows the porous ceramic microregenerators. Two microregenerators were fabricated with coarse pores and two with fine pores. The bottom photograph shows the test apparatus parts for evaluating the microregenerators, including the layered nickel-and-photoresist regenerator fabricated using LIGA¹ techniques.





Top: Porous ceramic microregenerators. Bottom: Apparatus parts for testing the microregenerators.

¹LIGA is a German acronym meaning lithography, electroplating, and molding.

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